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he movements of tagged adult plaice n the Irish Sea

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Abstract

A total of 16 771 plaice (mostly between 18 and 40 cm) were tagged in the eastern Irish Sea in the following areas: off St Bees Head (Cumberland), off Great Ormes Head (North Wales), Red Wharf Bay (North Wales), Caernarvon Bay, Cardigan Bay and Bristol Channel. The mean recapture rate was 28 per cent. Plaice in spawning condition released off St Bees Head and Great Ormes Head mostly returned to the same area to spawn each year and, although they dispersed throughout the north-east Irish Sea after spawning, very few were recaptured outside this region. By contrast, half of the recaptures from a mixed population of mature and immature plaice tagged in Red Wharf Bay in autumn were from outside the north-east Irish Sea, and they showed a marked tendency to migrate southwards. There was evidence of homing at spawning time among plaice released on the spawning grounds in Cardigan Bay and the Bristol Channel, and for a predominantly northwards dispersal after spawning. There was no common migration pattern shown by plaice tagged outside the spawning season in Caernarvon and Cardigan Bays, but the predominant direction of movement was normally southwards. From all release areas there were recaptures in the western English Channel but there appears to be very little return movement.

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ıtroduction

he early 1960s, the Lowestoft marine fish hatchery pro-
mme had reached the stage at which large numbers of
chery plaice were being produced at Port Erin, Isle of
n, and thought had to be given to the next stage of
ing to a harvestable size. This could have been tried in
eral possible environments, one of these being the
ural environment itself, and thus a support programme
started, the aim of which was to investigate the biology
laice in the Irish Sea, from the egg through to the adult
.

ome aspects of this work concerned with the juvenile
have already been published (e.g. Corlett 1966, Macer
7) and the present report deals with the results of tagging
eriments on the adult plaice. Although something was
wn about the movements of plaice in the Irish Sea,
re information was needed because, if hatchery plaice
e to be released, it was obviously important to find out
ey would remain in the release area, assuming that they
aved in a similar manner to the natural population
ch was tagged.

evious Work

e was a good deal of interest in plaice marking in the Sea in the early 1900s. Farran (1909, 1911) tagged a of 2 276 plaice off the east coast of Ireland at Dublin Drogheda from August 1905 to October 1907. The vast ority of recaptures were within 10 miles of the release t and Farran concluded that the stocks were, to a large nt, isolated.

n the other side of the Irish Sea there were two series of riments. In the first, summarized by Johnstone, Birtle and Smith (1922), 1 129 plaice were released off the ble Estuary (Lancashire) and 616 in Red Wharf and maris Bays (North Wales) over a period of several s (1904–13). In the second series, summarized by Daniel Fleming (1933), 1 000 plaice were tagged in 1929 and) in the following areas—Red Wharf Bay (463), Caeron Bay (177), Cardigan Bay (326) and the Ribble ary (34).

he results of these experiments showed that the Ribble ary fish underwent rather localized movements, but there was a migration of larger fish in autumn towards Isle of Man and towards Anglesey. There was interge between plaice tagged in Red Wharf, Caernarvon Cardigan Bays but also a general southerly movement the Bristol Channel, English Channel and to the south coast of Ireland. At the time these experiments were ducted, knowledge of plaice spawning areas was rather ted and this made it difficult to interpret the data. It known that spawning occurred off St Bees Head (Cumand) and it was surmised that there was another spawnarea in St George's Channel, from which eggs and larvae ted around Holyhead and into the Liverpool Bay area, ough it was admitted that there was no direct evidence his.

s a result of Simpson's (1959) work, it is now known the main spawning areas are off St Bees Head, off glas (Isle of Man), off Great Ormes Head (North es), in Caernarvon Bay, in Cardigan Bay, and in the tol Channel (off Hartland Point and Trevose Head). re is no evidence of spawning in St George's Channel or rift of eggs and larvae northwards and around Anglesey.

ill (1971) tagged plaice inshore near St Bees Head and d that very few were recaught outside the area between sle of Man and Cumberland, although these data cover a few months after liberation. Griffith (1966) reported in his work off the east coast of Ireland, the majority ecaptures were close to the release area, so confirming an's earlier work.

lethods and Arrangement of Data

: plaice were tagged with ebonite (rigid plastic) Petersen
:s attached by titanium or stainless steel wires. An en-
ved yellow disc was placed on the pigmented side of the
and a blank red one on the unpigmented side. The
imum length of fish accepted for tagging was normally
:m but occasionally some fish down to 14 cm were used.
y damaged fish were rejected.

ble 1 gives details of the tagging cruises. In addition to
cruises which formed part of the hatchery support pro-
mme, other tagging work conducted from this labora-
y and relevant to the present investigation has been
uded. As can be seen from Table 1, the area where most
ice were released was the north-east Irish Sea, the reason
this being that it was here that it was proposed to carry
trial releases of hatchery plaice. In particular, Red
arf Bay and adjacent bays were selected as being pro-
ing areas for hatchery releases.

n the north-east Irish Sea, the aims of the tagging were
)-fold: firstly to investigate movements of immature
ice close inshore, and secondly to investigate movements
mature plaice; the latter were tagged off St Bees Head
l Great Ormes Head, and the former in Red Wharf and
acent bays. In addition, O-group plaice were tagged with
uid latex and part of this work has already been pub-
ied (Macer 1967).

The recapture data are presented in the form of charts
l tables. In the charts, the recapture positions have been
)uped into rectangles, each of which is 10 minutes lati-
e × 10 minutes longitude (10 n miles × *c.* 6 n miles). In
tables, the rectangles have been grouped into larger
as, as shown in Figure 1. In one of these areas, the north-
t Irish Sea, two smaller areas marked A and B are shown
l these are taken to be the spawning grounds. They
lude rectangles in which plaice eggs in an early stage of
elopment have consistently been found on plankton
veys (based largely on the work of Simpson 1959 and on
)ublished data kindly supplied by my colleague Mr D.
rding).

With respect to time of recapture, it has been found con-
ient to group the data into four-monthly periods as
ows: January to April (period 1), May to August (period
and September to December (period 3). It is thought
t these periods correspond approximately to natural
iods in the annual life-cycle of the mature plaice, such
t period 1 could be termed 'spawning'; period 2, 'feed-
'; and period 3, 'pre-spawning'.

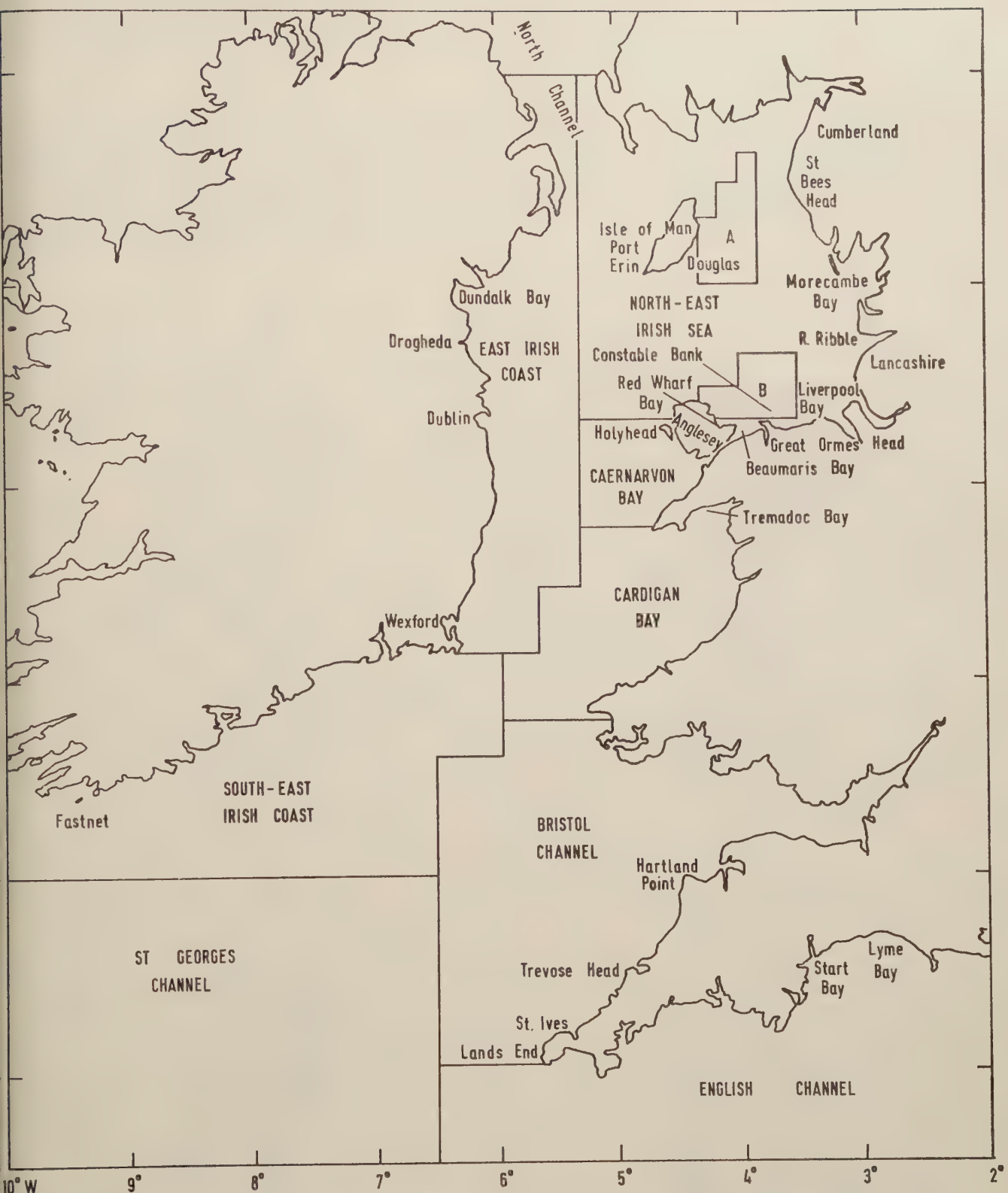
For each release or set of releases in a particular area
re are three charts, one for each of the three periods,
spective of the year of recapture. The tables (Appendix
)les 2–9) give the results in more detail, in that the num-
s of plaice recaptured in each area are shown for each
r after release. All the results are conveniently sum-
rized in Appendix Table 1. Although details of each
ase on each ground are given in Table 1, in the recapture
rts and appendix tables separate releases at a similar
e of year in the same area have been combined, since
y all show a similar pattern. Thus, for example, the set
charts and tables showing recaptures of fish released off
eat Ormes Head is based on 8 separate releases.

Although detailed recapture positions were usually given by the fishermen, sometimes positions were rather vague—'Cardigan Bay' or 'Morecambe Bay' being typical examples—and in such cases specific rectangles were allocated. In the present context, the term 'Irish Sea' is used in a broad sense to cover the whole of the sea area bounded by a line joining Land's End and Fastnet in the south, and latitude 55°N in the north. The term 'migration' is also used in a broad sense to describe any movement from the point of release to the point of recapture.

TABLE 1 *Details of plaice tagging in the Irish Sea*

Area	Cruise*	Dates	Numbers		% recaptured	Area totals		
			Released	Recaptured		Releases	Recaptures	% recaptured
St Bees Head	P 2/63	22–23 February 1963	75	30	40.0			
	P 4/64	27 February–2 March 1964	437	220	50.3	512	250	48.8
Morecambe Bay	P 10/62†	27–28 May 1962	63	24	38.1	63	24	38.1
Great Ormes Head	P 2/60	8–13 February 1960	375	110	29.3			
	P 2 & 3/63	19 February–6 March 1963	2 291	405	17.1			
	P 4/64	23–26 February 1964	1 602	400	25.0			
	P 3/65	24 February–2 March 1965	1 155	392	33.9			
	P 4/65	14–23 March 1965	2 081	610	29.3			
	P 5/65	4–9 April 1965	2 470	776	31.4			
	P 6/65	30 April–7 May 1965	666	147	22.1			
	C 6B/65	2–7 May 1965	397	89	22.4	11 037	2 929	26.5
Red Wharf Bay	P 17/62	11–16 November 1962	720	213	29.6			
	P 10/63	16 June 1963	152	44	28.9			
	P 17/63	21–24 October 1963	1 029	349	33.9			
	P 4/64†	22 February 1964	44	11	25.0			
	P 15/64	26–27 October 1964	1 077	244	22.7	3 022	861	28.5
Constable Bank	P 15/64	21 October 1964	143	34	23.8	143	34	23.8
Beaumaris Bay	P 15/64	21–28 October 1964	276	96	34.8	276	96	34.8
Caernarvon Bay	P 10/62	2–3 June 1962	253	127	50.2			
	P 15/64	19–20 October 1964	834	246	29.5	1 087	373	34.3
Tremadoc Bay	P 15/64	18 October 1964	38	5	13.2	38	5	13.2
Cardigan Bay	P 10/62	5–6 June 1962	247	12	4.9			
	P 4/64	3–5 March 1964	246	74	30.1	493	86	17.4
Trevose Head	SL 5/59	2–5 April 1959	100	37	37.0	100	37	37.0
Total for all areas			16 771	4 695	28.0	16 771	4 695	28.0

* P=RV PLATESSA, C=RV CLIONE, SL=RV SIR LANCELOT.
† Two cruises on which only small numbers of fish were tagged are included here but are not discussed in detail in the text.



. 1 The locations of places mentioned in the text, including the subdivisions of the recapture areas. The areas marked 'A' and 'B' the St Bees Head and Great Ormes Head spawning grounds, respectively.

Distribution of Fishing Effort

ne number of tagged fish returned from any particular ea depends upon the number of tagged fish present and e amount of fishing. Ideally, tagging data should be pre-nted in the form of *recaptures per unit of fishing effort*, but is is not possible in the present work, since effort data are ot available in sufficient detail. Some information is available, however, in the form of fishing effort by rectangle (each of which is 1° of longitude by 30′ of latitude) by UK vessels over 40 feet in length. This information is shown in Figure 2, the data being the average for the years 1966–68, arranged in four-monthly periods.

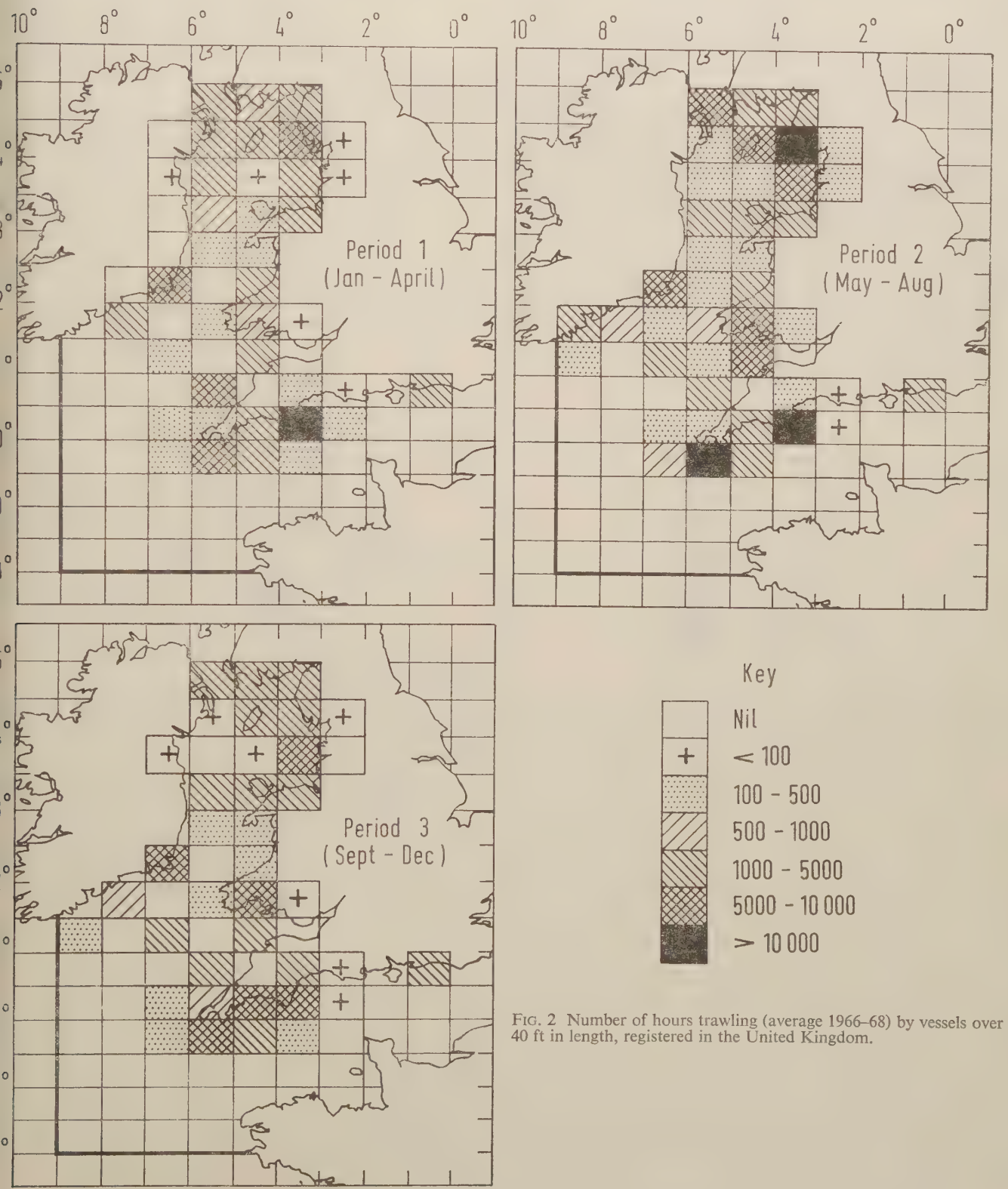


FIG. 2 Number of hours trawling (average 1966–68) by vessels over 40 ft in length, registered in the United Kingdom.

It can be seen that effort is low in Cardigan Bay and high in the north-east Irish Sea and coastal areas of the western English Channel. It is also apparent that effort increases markedly in the summer period. Information on effort from vessels under 40 feet is not normally collected, but some idea of their importance in the present context can be gained from their contribution to landings of plaice, which amounted to an average of 17.9 per cent of the total in 1967 and 1968, in the Irish Sea and western English Channel (regions VIIA, VIIE, VIIF and VIIG).

It is also interesting to compare the movements of tagged plaice with the seasonal distribution of the species as deduced from fishing vessel data. Such data are shown in Figure 3, as the average landings of plaice (1966–68) by rectangles by UK vessels over 40 feet in length. In period 1 (January to April), there are high catch levels in areas known to be spawning grounds (St Bees Head and Trevose Head) and in others presumed to be so (Start Bay and the Sussex coast). In period 2 (May to August), catches generally increase and are particularly high in the north-east Irish Sea, off Wexford (Ireland), in the Bristol Channel and in Start Bay. In period 3 (September to December), rectangles in Liverpool Bay and the Bristol Channel show very high catch levels. This method of presentation is open to the objection that it is too strongly biassed by differences in fishing effort, but in the present work it has been found to give a more accurate picture of what is known of plaice distribution than a diagram showing catch per unit effort. In such a diagram, it is found that some rectangles are heavily biassed by low values of fishing effort.

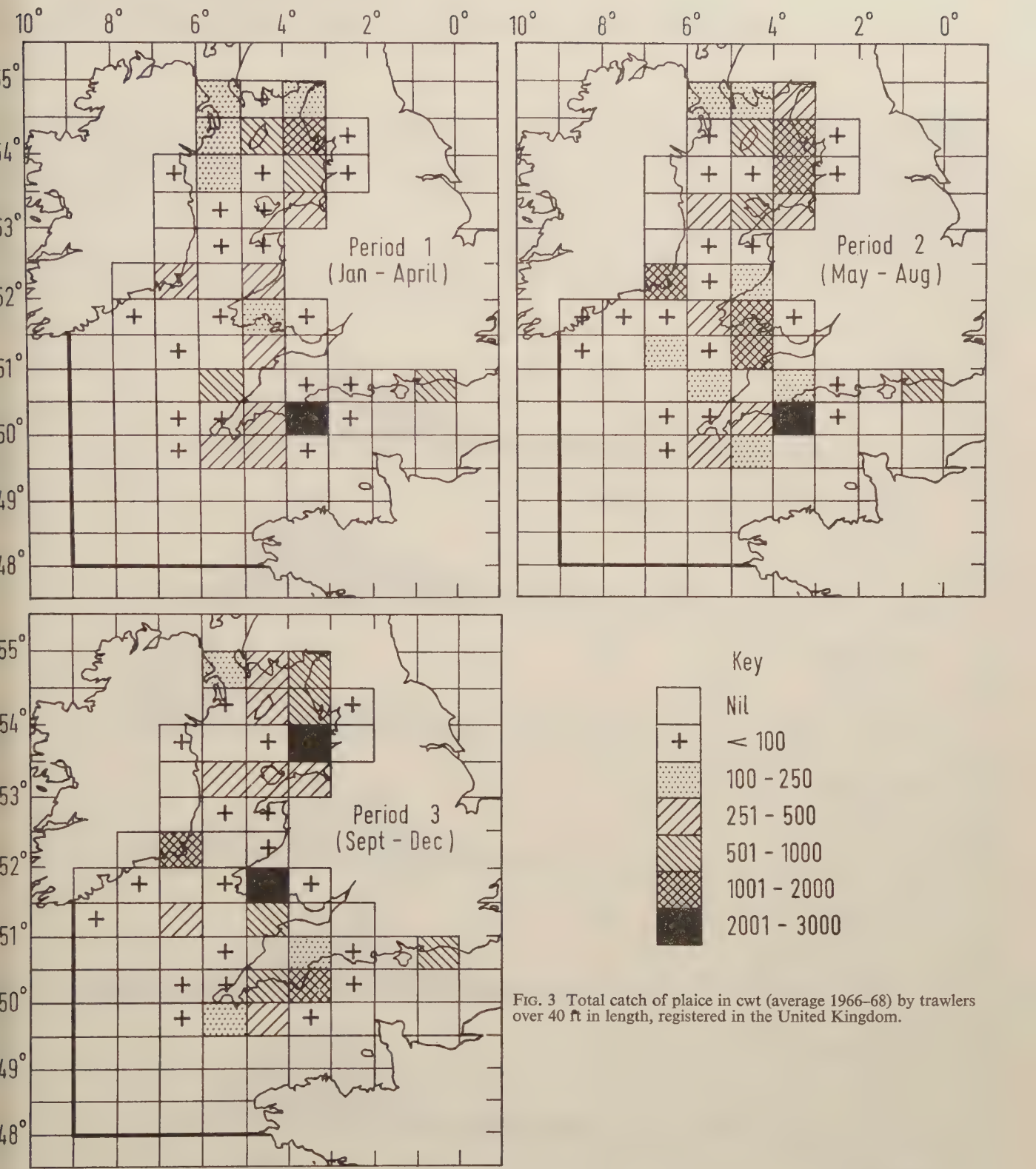
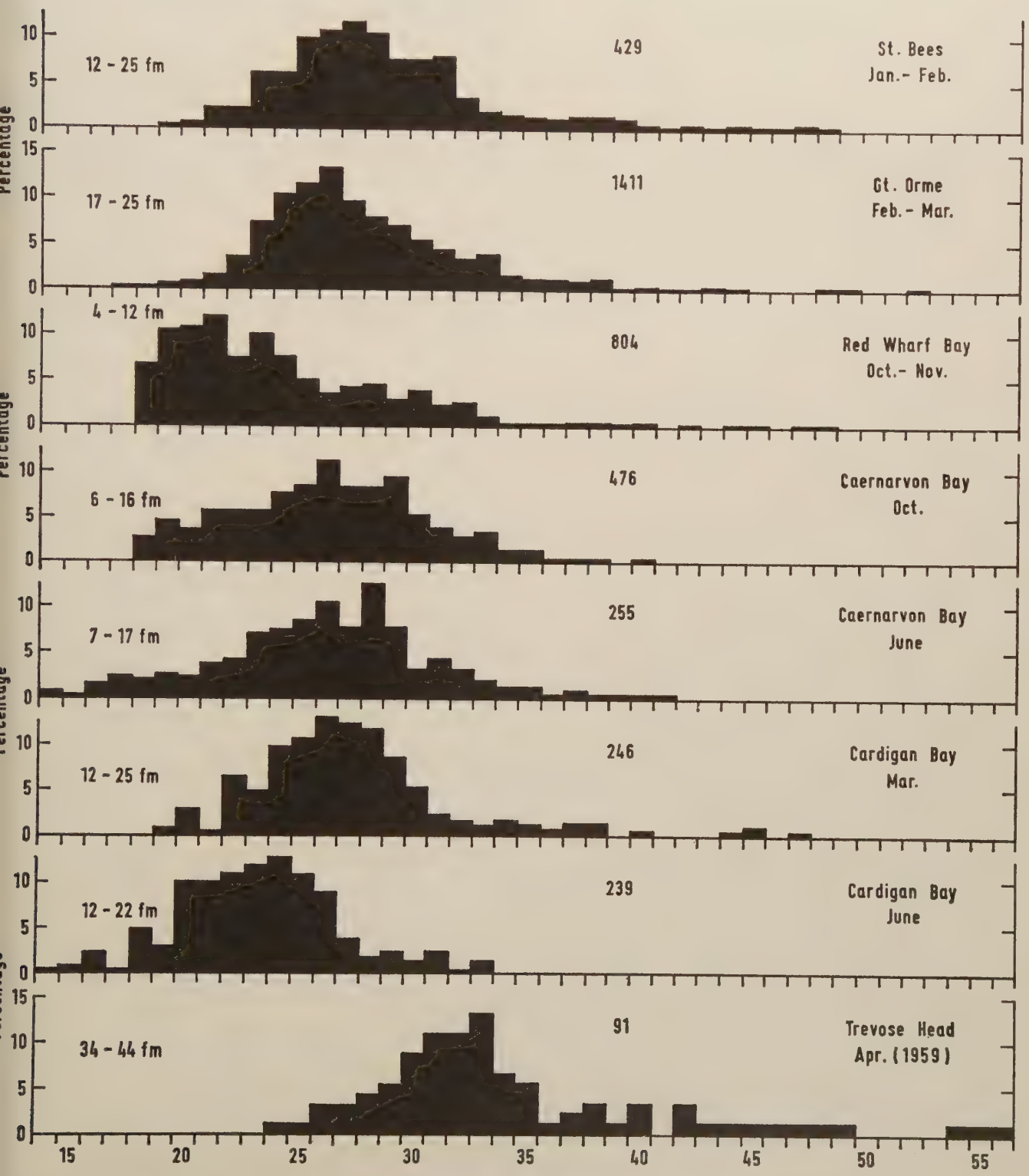


FIG. 3 Total catch of plaice in cwt (average 1966–68) by trawlers over 40 ft in length, registered in the United Kingdom.

.ength Distributions of Plaice on Release

ength frequency histograms for the plaice as tagged are iown for each area in Figure 4. Where large numbers of laice were released, for example off Great Ormes Head and .ed Wharf Bay, the distributions have been constructed om a representative sample.

he length compositions of the fish tagged on the spawning rounds off Great Ormes Head and St Bees Head were milar, but many of those tagged inshore in Red Wharf Bay were much smaller. In Cardigan Bay the plaice tagged in June were generally smaller than those tagged in March. The largest plaice occurred off Trevose Head, in contrast to Simpson's (1959) work, in which the smallest plaice were found in this area. This difference is probably accounted for by an increase of about 10 fathoms in depth of capture, since it is well known that size in plaice is correlated with depth (e.g. Wimpenny 1953).



. 4 The length distribution of plaice as tagged for each release area. The depth of capture and sample size are shown.

The Current System

ne hydrography of the Irish Sea has been investigated by owden (1955), Lee (1960) and Ramster and Hill (1969). ne main surface residual flow is north-going, with water tering the Irish Sea through St George's Channel and aving through the North Channel. There are eddy systems the Bristol Channel, Cardigan Bay and in the north-east ish Sea. The most detailed information on residual flow lates to the last-named area (Ramster and Hill 1969). ere, there is an extensive anticlockwise swirl in the surface aters of the southern half of the area; the bottom currents, hile showing a similar pattern, tend to be deflected towards e coastline.

The relevance of these observations to the biology of the aice is that (1) the eddy systems would tend to minimize rval dispersal (Lee 1960) and this is borne out by plankton rveys (Simpson 1959), and (2) onshore bottom currents ould carry the metamorphosed larvae towards their usual allow-water habitat.

Results

he present experiments can conveniently be considered in ree groups:

) those in which the fish were tagged at spawning time on known spawning grounds and were observed to be in spawning condition;

) the Red Wharf Bay experiments, in which some information on maturity was collected from tagging rejects;

) other experiments, in which no data on maturity were collected.

) TAGGING EXPERIMENTS ON SPAWNING PLAICE

These were made in the following areas: off St Bees ead, off Great Ormes Head, in Cardigan Bay and off revose Head (Bristol Channel).

) *St Bees Head* (*Figure 5, Appendix Table 2*)

There were two releases in this area, one in February 963 and the other in March 1964, giving a total of 512 aice tagged. In the months immediately following the releases (period 1), the recaptures were mainly in the St Bees ea, with the notable exception of one off the south-east ast of Ireland and another off Dundalk Bay. During the mainder of the first year, movements were rather limited nd mostly confined to the area of the north-east Irish Sea, though one fish reached the Bristol Channel in period 2. the second and subsequent years, this restricted pattern of ovement was repeated, and it is of interest to note that ost of the plaice returned to the St Bees area in period 1 he spawning season). This is shown more clearly in Table which gives all the period 1 recaptures (excluding the first ar's) from the releases on spawning grounds. Only 2.4 per nt of the St Bees plaice were subsequently recaptured at e Great Ormes spawning ground at spawning time. The gh percentage (53.7 per cent) of recaptures in the north-st Irish Sea outside the main spawning areas may seem rprising but, although there probably is some spawning er the whole region, some of the recaptures were almost rtainly of fish on passage to or from the spawning ground. ne limited extent of the migrations can be seen in Appendix Table 1, which shows that 94.3 per cent of recaptures of St Bees plaice were from the north-east Irish Sea.

ABLE 2 *Recaptures from period 1 in all years except the first, of plaice tagged on spawning grounds during the spawning season*

ecapture area	Release area							
	St Bees Head		Great Ormes Head		Cardigan Bay		Trevose Head	
	No.	%	No.	%	No.	%	No.	%
Bees Head	17	41.5	14	3.4	–		–	
eat Ormes Head	1	2.4	264	65.0	–		–	
her areas in NE. Irish Sea	22	53.7	89	21.9	–		–	
ernarvon Bay	–	–	10	2.5	2	22.2	–	
rdigan Bay	–	–	5	1.2	4	44.4	–	
istol Channel	–	–	3	0.7	–		6	100.0
glish Channel	–	–	–	–	–		–	
George's Channel	–	–	2	0.5	–		–	
. Irish coast	–	–	1	0.2	1	11.1	–	
Irish coast	–	–	5	1.2	1	11.1	–	
her areas	–	–	–	–	–		–	
sition unknown	1	2.4	13	3.2	1	11.1	–	
tal	41		406		9		6	

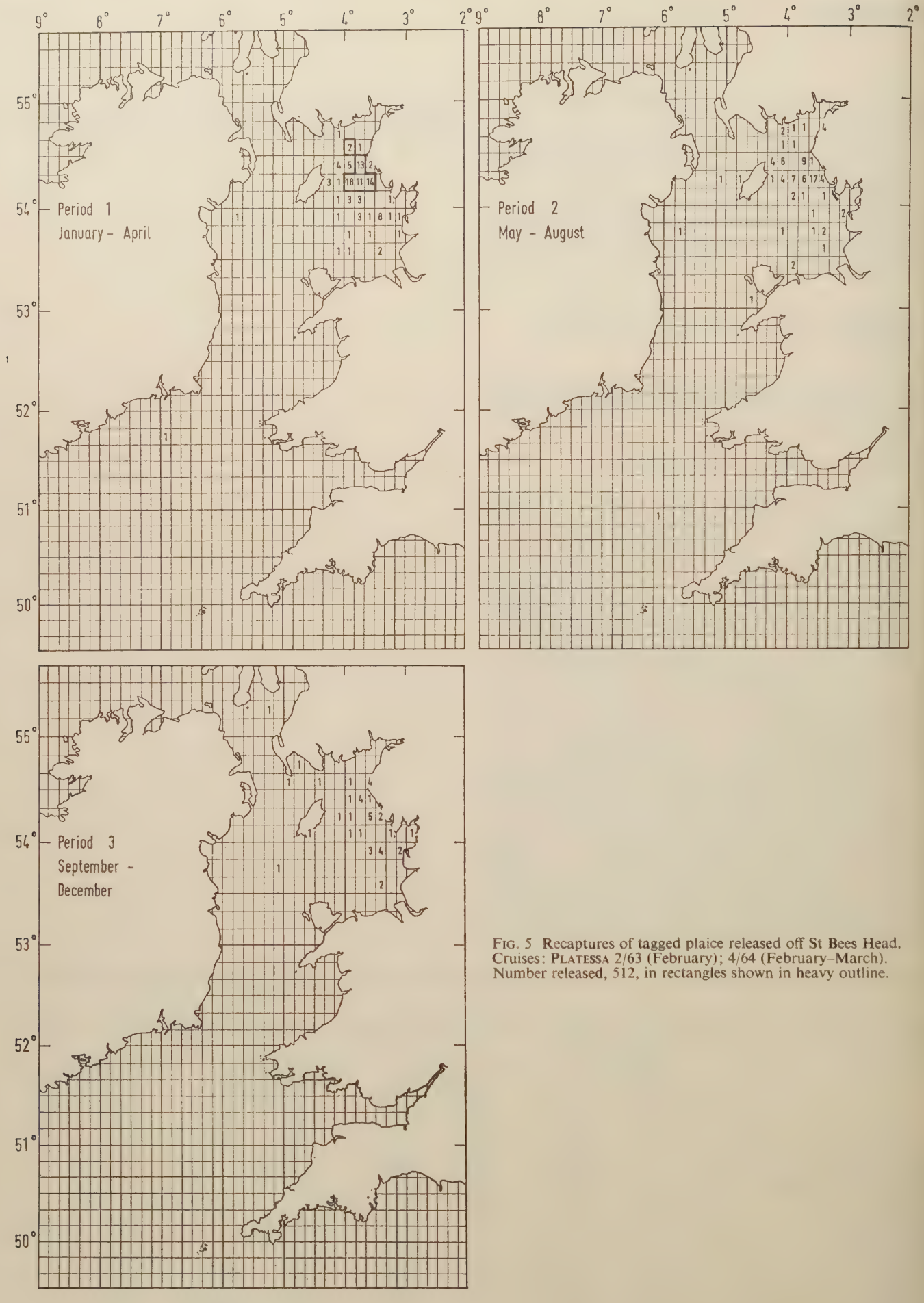


FIG. 5 Recaptures of tagged plaice released off St Bees Head. Cruises: PLATESSA 2/63 (February); 4/64 (February–March). Number released, 512, in rectangles shown in heavy outline.

Great Ormes Head (Figure 6, Appendix Table 3)

his spawning area has been more intensively studied n any other, partly due to its convenience as a working a, in that shelter from the prevailing south-westerly ds is near at hand. A total of 11 037 plaice have been ged on nine cruises, covering the months from February arly May.

he movements of plaice tagged in this area show a ilar seasonal pattern to those tagged off St Bees Head. the non-spawning season (periods 2 and 3), recaptures ur throughout the north-east Irish Sea and are parti- arly numerous in the Morecambe Bay area during the mmer. At spawning time (period 1), most of the plaice rn to the Great Ormes Head area, and only 3.4 per cent ble 2) were recaptured on the St Bees Head ground. As h the St Bees plaice, movement was largely confined to area of the north-east Irish Sea and only 7.6 per cent ppendix Table 1) of the recaptures were outside this area. e farthest distances travelled were by fish recaptured in English Channel and off the north coast of Ireland. ere were some returns reported as coming from the North a but these are highly suspect, since the sources of infor- tion were not reliable.

Cardigan Bay (Figure 7, Appendix Table 4)

This was a small release of 246 plaice in March 1964, of ich 30.1 per cent were recaptured. This recapture rate is ghtly greater than the average for all experiments (28 per t, Table 1) and is of interest since it has been shown viously (Figure 2) that fishing effort in Cardigan Bay is atively low. In fact, only 27 per cent of the recaptures ne from Cardigan Bay and this may be contrasted with experiments off Great Ormes Head and St Bees Head, which 92.4 and 94.3 per cent respectively of all recaptures re within the north-east Irish Sea, though it should be nted out that the latter region covers a somewhat wider a than that designated as Cardigan Bay (Figure 1).

The low proportion of returns from the release area uld be due to the relatively low effort there and to emigra- n of the tagged fish. The above-average recapture rate gests that there was more emigration from Cardigan Bay n occurred with the spawning plaice released in the north- t Irish Sea. This suggestion is reinforced by consideration Table 3, in which is given the number of *exotic* recaptures each release of spawning plaice. For the St Bees and eat Ormes Head releases, exotic recaptures refer to those ght outside the north-east Irish Sea, and for Trevose ad, to those caught outside the Bristol Channel. It can be seen that the number of exotics per 1 000 fish released is much higher in the Cardigan Bay experiment than in those off St Bees and Great Ormes Head, and this is also apparent if the first year's recaptures are omitted, so allowing more time for movement.

The predominant direction in which the migrant fish travelled from Cardigan Bay was to the north into Caernarvon Bay (10.8 per cent) and into the north-east Irish Sea (20.3 per cent). The Bristol Channel also provided some recaptures (12.2 per cent) and there was 13.5 per cent from the east Irish coast. The question as to whether the fish return each year to Cardigan Bay to spawn is difficult to answer, due to the small number of recaptures in period 1 after the first year (Table 2). However, the data suggest that homing at spawning time may not be so marked as with the other spawning populations investigated.

BLE 3 Exotic *recaptures of plaice tagged on spawning grounds. 'Exotic' refers to fish which were recaptured in areas outside that in which the release took place—see text for further explanation*

Release area	No. released	All years		Excluding first year	
		No. of exotics recaptured	No. per 1 000 fish released	No. of exotics recaptured	No. per 1 000 fish released
St Bees Head	512	14	27.3	6	11.7
Great Ormes Head	11 037	224	20.3	123	11.1
Cardigan Bay	246	54	219.5	18	73.2
Trevose Head	100	15	150.0	4	40.0

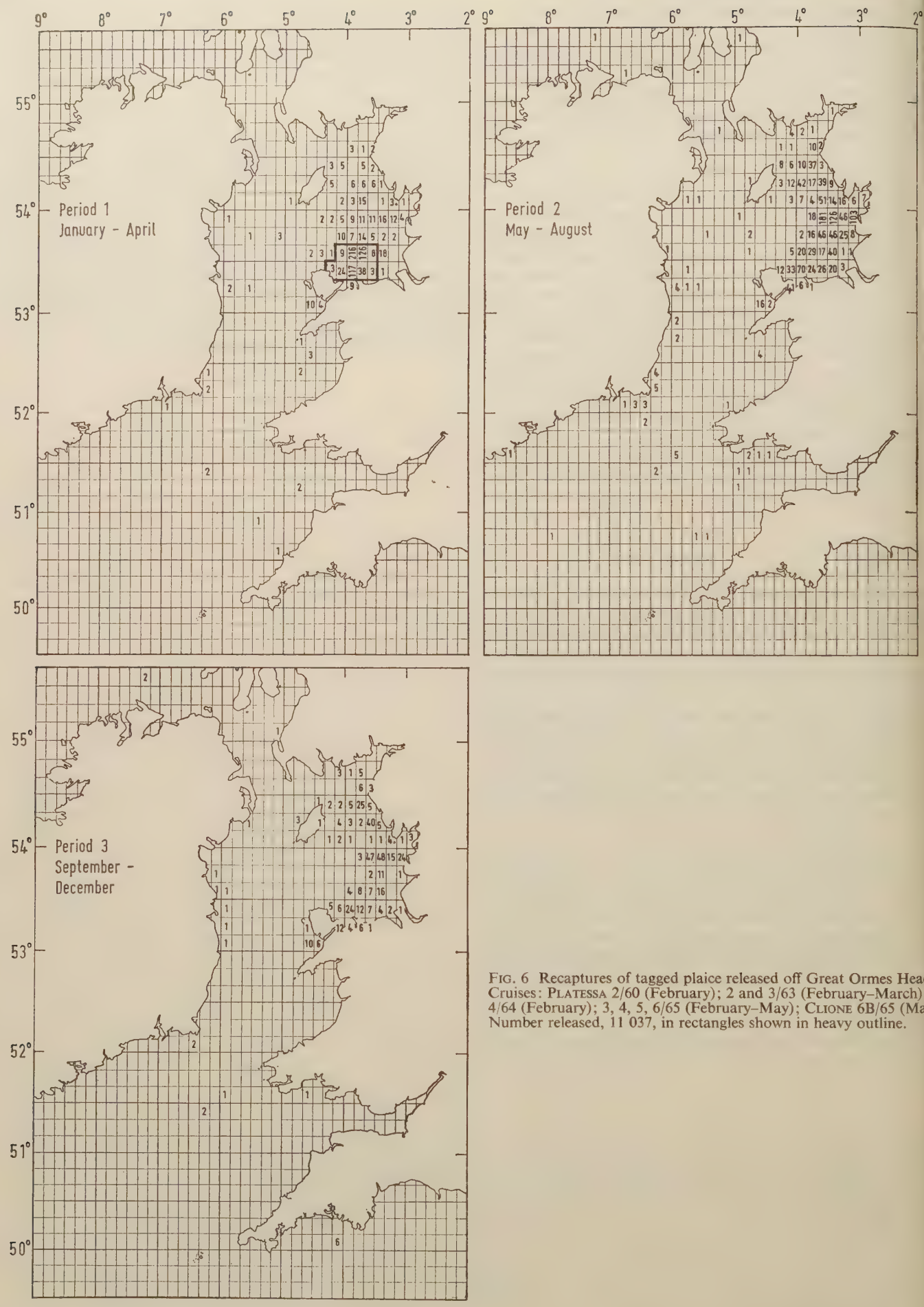


FIG. 6 Recaptures of tagged plaice released off Great Ormes Head. Cruises: PLATESSA 2/60 (February); 2 and 3/63 (February–March); 4/64 (February); 3, 4, 5, 6/65 (February–May); CLIONE 6B/65 (May). Number released, 11 037, in rectangles shown in heavy outline.

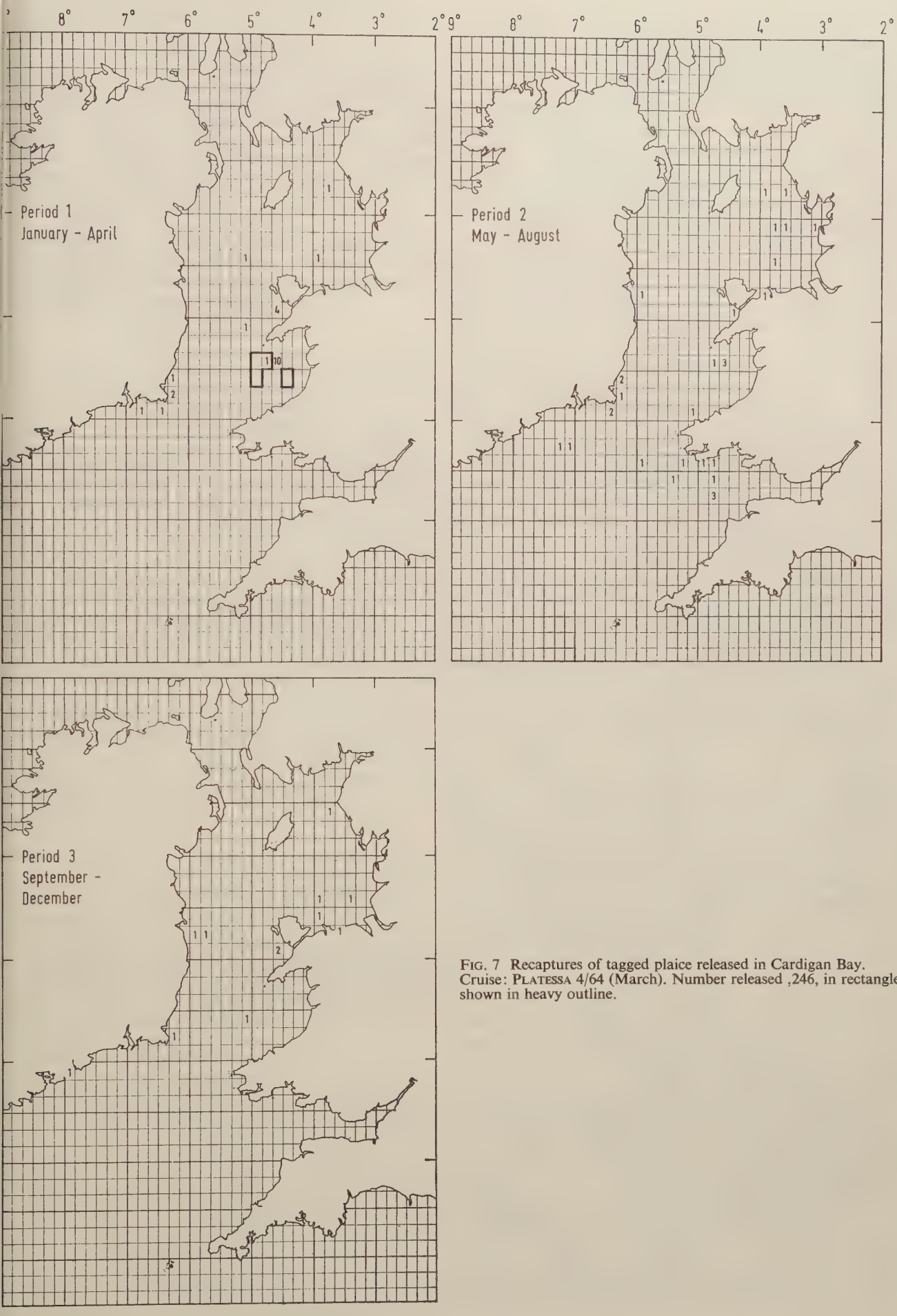


FIG. 7 Recaptures of tagged plaice released in Cardigan Bay. Cruise: PLATESSA 4/64 (March). Number released ,246, in rectangles shown in heavy outline.

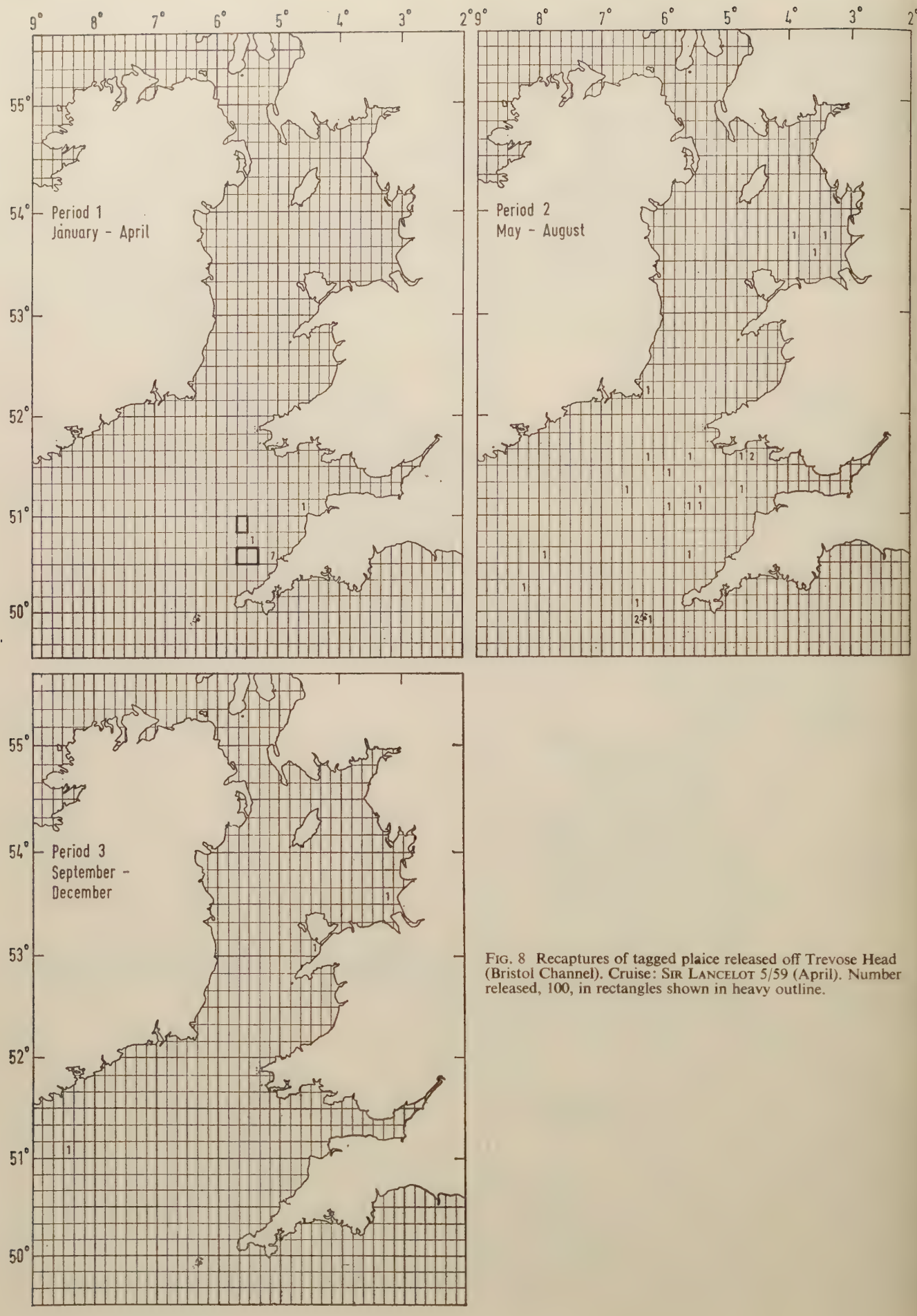


FIG. 8 Recaptures of tagged plaice released off Trevose Head (Bristol Channel). Cruise: SIR LANCELOT 5/59 (April). Number released, 100, in rectangles shown in heavy outline.

Trevose Head (Bristol Channel) (Figure 8, Appendix Table 5)

his was another small release of 100 plaice, in April . The majority of recaptures (59.5 per cent) were from Bristol Channel but there was some movement to the h (16.2 per cent) as far as the Morecambe Bay area, and westwards into St George's Channel (5.4 per cent) and e Irish coast (8.1 per cent), and to the south around the of Scilly (8.1 per cent).

terpretation of homing at spawning time (Table 2) is n hampered by inadequate data but it is perhaps note- hy that all six returns in period 1 were from the release , suggesting that homing does take place.

MMARY OF TAGGING OF SPAWNING PLAICE

general it seems that when Irish Sea plaice disperse spawning, the predominant movement is northwards. e spawning in Cardigan Bay and the Bristol Channel v a greater degree of dispersal than those in the north- Irish Sea (Table 3). There is good evidence that the fish rn to the same areas each year to spawn, though this nomenon does not appear to be so marked in Cardigan as in other areas.

THE RED WHARF BAY EXPERIMENTS
(Figure 9, Appendix Table 6)

ecause Red Wharf Bay was considered to be one of the t suitable bays for the release of hatchery-reared plaice, irly detailed ecological investigation was carried out e (Macer 1967) and, as part of this work, 3 022 plaice tagged over a period of three years (Table 1). Most of releases took place in October and November, since e was evidence that plaice were more abundant in the at this time (Johnstone *et al.* 1922).

he mean length of the tagged plaice was considerably than that of the fish tagged on the nearby spawning nd off Great Ormes Head (Figure 4) and, although the imum size for tagging was usually set at 18 cm, many e smaller than this length were caught. No assessment he state of maturity of the individual tagged fish was e but, by using data collected by examination of fish ted as unsuitable for tagging, it is possible to estimate 53 per cent of the plaice released were mature, that is, would spawn in the current season.

he distance separating Red Wharf Bay from the adja- spawning ground to the north-east is only about 10 s and it might therefore be expected that plaice tagged hese two areas would show similar patterns of move- t; however, inspection of Figures 6 and 9 (and Appendix le 1) shows that there are considerable differences. Thus, reas 92.4 per cent of the recaptures of the Great Ormes e were within the north-east Irish Sea, the correspond- proportion for the Red Wharf Bay fish was 49.9 per and the remainder showed a marked tendency to move hwards. There were already recaptures from Caernar- Bay in the first two months after release and, by period 1 he second year, the fish had spread southwards as far as English Channel and, to a smaller extent, westwards to coast of Ireland. One of the fastest journeys was by a m plaice released on 23 October and recaptured off St Ives (north Cornwall) on 22 January. This was a journey of about 200 miles by the shortest route, which means that the fish must have averaged about 22 miles per day as a minimum estimate, since it may not have taken the shortest route and may have been in the recapture area for some time prior to being taken.

The proportion of recaptures outside the north-east Irish Sea (about one half) is approximately the same as the estimated proportion of plaice which were mature at the time of tagging, and this fact might be taken to suggest a difference in migration pattern between immature and mature plaice. Because the state of maturity of the individual tagged plaice at release and at recapture is unknown, there is no direct information on this question, but some conclusions can be drawn from indirect evidence. Thus a difference in maturity would be expected to show up as a size difference and Table 4 shows the lengths at recapture of fish released in Red Wharf Bay. It can be seen that, although there are some small differences between the mean lengths of the recaptures in the north-east Irish Sea and those caught in other areas, there is no overall clear-cut difference which would indicate a maturity separation. The grand mean length for all areas except the north-east Irish Sea is 28.18 cm, which is very similar to that of the recaptures in the latter area itself. This evidence suggests, therefore, that the plaice which migrated south from Red Wharf Bay included both mature and immature individuals. As Harden Jones (1968) points out, one might expect that the mature plaice found in Red Wharf Bay in autumn would spawn off Great Ormes Head, but comparatively few seem to do so. Thus, considering recaptures of plaice, released in Red Wharf Bay, from all years during the spawning season (period 1), only 18 per cent were from the Great Ormes Head area. An analysis of the returns in which males and females were considered separately did not reveal any differences in migration pattern.

The Red Wharf Bay experiments can be summed up as follows: (1) about 53 per cent of the fish tagged were probably mature; (2) 50.1 per cent of the recaptures were outside the north-east Irish Sea, mostly from areas to the south; (3) indirect evidence suggests that the migrant fish were a mixture of mature and immature plaice; (4) although the Great Ormes Head spawning ground is only about 10 miles away, only 18 per cent of recaptures in the spawning period (January–April) were from that area, and 25 per cent from the wider area of the north-east Irish Sea.

From the evidence of egg distributions (Simpson 1959) and hydrography (Lee 1960), it seems likely that the eggs and larvae of Irish Sea plaice do not drift far from the spawning grounds, so that the young plaice probably grow up in local sandy bays. Red Wharf Bay is such a nursery area (Macer 1967) and it is probable that its young plaice population is recruited from the Great Ormes Head spawning ground. There may also be movement of older plaice into the bay from other areas, although what is concluded by Johnstone *et al.* (1922) to be such a movement from the Lancashire coast is clearly a spawning migration to the Great Ormes Head ground.

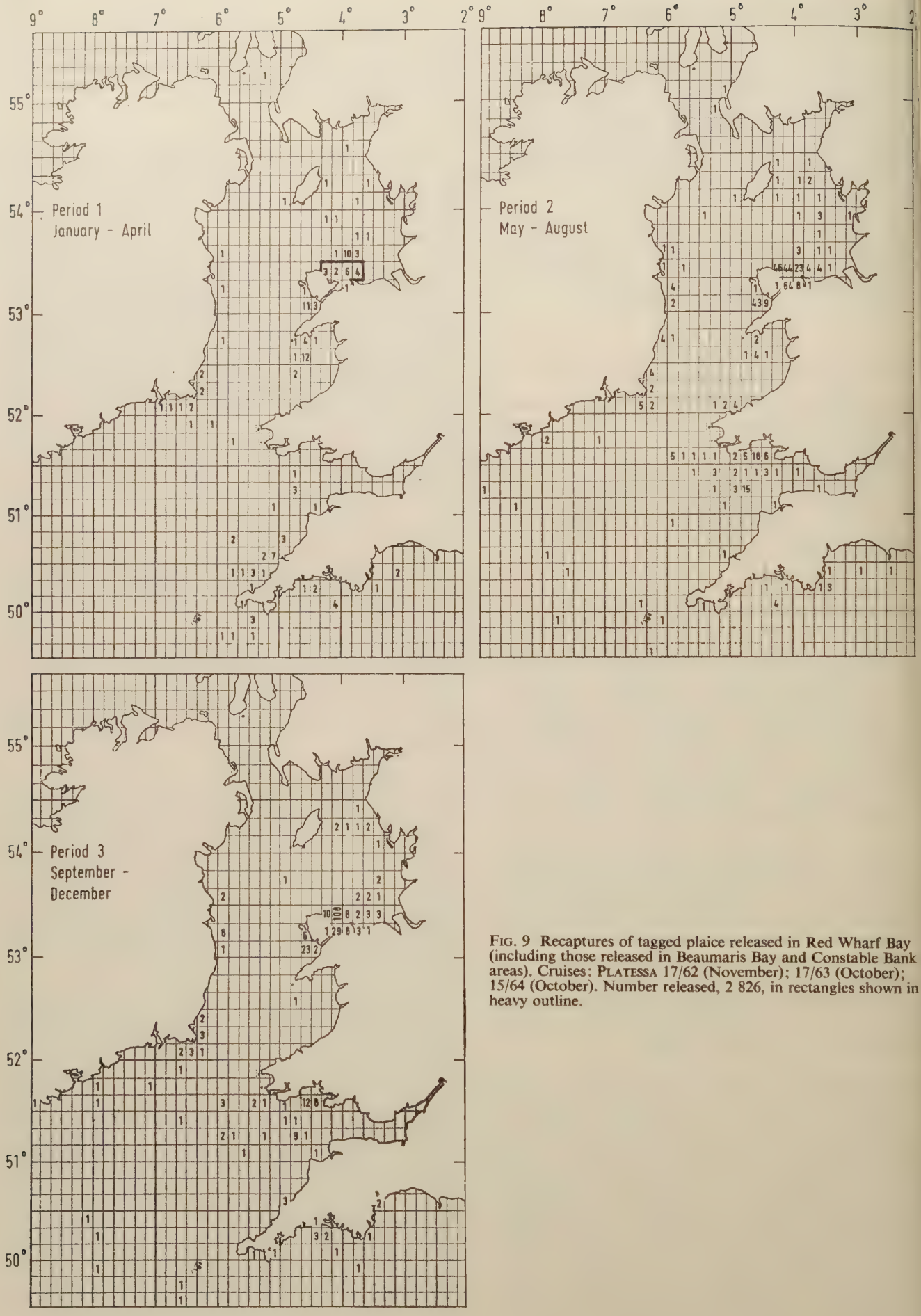


FIG. 9 Recaptures of tagged plaice released in Red Wharf Bay (including those released in Beaumaris Bay and Constable Bank areas). Cruises: PLATESSA 17/62 (November); 17/63 (October); 15/64 (October). Number released, 2 826, in rectangles shown in heavy outline.

: 4 *Length at recapture of plaice tagged and released in Red Wharf Bay*

ure area	Number recaptured	Mean length (cm)	Range (cm)	Standard deviation
ish Sea	328	28.43	15–51	5.36
rvon Bay	85	25.49	18–41	4.04
an Bay	38	27.37	21–38	3.77
Channel	147	28.61	20–40	3.98
n coast	41	29.20	22–41	4.17
sh coast	26	32.19	26–41	4.48
rge's Channel	5	33.00	27–38	4.47
h Channel	47	28.74	19–39	3.92

e Red Wharf Bay experiments may suggest that some Sea plaice spawn to the south of their nursery area den Jones 1968) and in order to see if this principle vider applications, the results of two other experiments mall plaice tagged close inshore by previous authors be examined. Firstly, Johnstone *et al.* (1922) liberated 5 small plaice (modal length 20.5 cm) off the River le estuary in June and July. The recaptures indicated itial movement into slightly deeper water and then in mn the smaller fish moved into shallower water, while was a clear migration of the larger fish to the spawning nds off Great Ormes Head and between the Isle of Man Cumberland. The most significant fact in the present ext is that only 4.7 per cent of the recaptures were out- the north-east Irish Sea, compared with the equivalent e of 50.1 per cent for the Red Wharf Bay fish.

ne second experiment with which the Red Wharf Bay lts can be compared is a release of 2 300 young plaice St Bees Head in October 1950 by Hill (1971). Un- nately, only recaptures up to the following February given but it is clear that, within this time period the St plaice showed only very localized movements com- d with the Red Wharf Bay fish, and there were no ptures outside the north-east Irish Sea.

ne movements of plaice tagged in Red Wharf Bay in mn do not, therefore, seem to be typical of the move- ts of inshore plaice tagged elsewhere in the north-east Sea. Although there is little direct evidence from tag- , it does appear that there may be immigration of plaice Red Wharf Bay in autumn, since Johnstone *et al.* 2) refer to the fishery there as starting about November ending in December or January 'sometimes very pptly'. This, incidentally, contrasts with the availability plaice off the Cumberland coast, which, according to (1971), falls rapidly in October/November and remains until May. It may therefore be the case that plaice rating south from the north-east Irish Sea collect in Red arf Bay before passing into Caernarvon Bay or towards Irish coast. If this was the case, it might be expected that ce tagged at other times of the year in Red Wharf Bay ld not show the same degree of dispersion. The only rmation on this point comes from a small release (152) there in June 1963 (Table 1); 86.4 per cent of the re- tures (78.6 per cent excluding first year) were from the th-east Irish Sea (mostly in the Red Wharf Bay area) and e this proportion is much larger than in the autumn eriments, it does lend a little support to this hypothesis.

Most workers who have studied migration have recog- ed three types (Harden Jones 1968): feeding, wintering reproductive. The southwards movement of mature plaice from Red Wharf Bay could be classed as a reproductive (spawning) migration and it corresponds to the usual type in which the migration is contranatant (Harden Jones 1968), since the residual flow through the Irish Sea is northwards (e.g. Lee 1960, Ramster and Hill 1969). The consistent recaptures on the Trevose Head spawning ground in period 1 (Figure 9), for example, strongly suggest that some of the Red Wharf Bay plaice spawn there. It is possible that after spawning these fish return to the Red Wharf Bay area, since it has already been shown that some plaice tagged off Trevose Head have been recaptured in the north-east Irish Sea. This migration pattern could also apply to the spawning grounds in Caernarvon and Cardigan Bays, since plaice released in Red Wharf Bay have been recaptured in these areas in period 1 and reverse movements have also occurred.

In interpreting these movements, the difficulty arises that the origin of any particular plaice, that is, the location of the parent stock from which it was spawned, is unknown. Thus, to take an example, it cannot be stated that the migration of plaice tagged off Trevose Head and recaught in the north-east Irish Sea is a return movement, since it is not known if the fish had come from the latter area or whether they had previously lived exclusively in the Trevose Head area. This question of the identity of populations might, perhaps, best be answered by an investigation of otolith characteristics similar to those undertaken by de Veen and Boerema (1959) on North Sea plaice. The tagging results suggest that the spawning populations off Great Ormes Head and St Bees Head are fairly discrete, but this is not so clear for those in Cardigan Bay and the Bristol Channel.

A southwards movement of immature as well as mature plaice from Red Wharf Bay has been inferred and, although the movement of the mature fish can be classed as a spawning migration, it is more difficult to account for the movements of the immature fish. It is possible, for example, that these plaice were not indigenous to the north-east Irish Sea and were returning south for overwintering. Simpson (1959) found no evidence of drift of eggs from one spawning area into another, although it is possible that eggs and larvae could pass from Caernarvon Bay into the north-east Irish Sea through the Menai Strait. With the possible exception of this latter case, therefore, a migration of young fish towards the area where they were spawned seems to be unlikely.

(c) TAGGING EXPERIMENTS OUTSIDE THE SPAWNING SEASON

(i) *Caernarvon Bay* (*Figures 10 and 11, Appendix Tables 7 and 8*)

There were two releases here, in June 1962 and October 1964 (Table 1). In the 1962 experiment (Figure 10), there was a high proportion of recaptures (81.1 per cent) from the release area, partly due to the fact that several trawlers arrived shortly after the fish had been released. Thus if the first year's recaptures are excluded, the proportion falls to 50 per cent. The migrant fish moved northwards into the north-east Irish Sea and westwards towards the Irish coast, and it is interesting to note that there were no recaptures to the south in this experiment.

By contrast, there was a southerly movement from the October 1964 release (Figure 11). Then, in addition to recaptures to the north and west, there were also returns from Cardigan Bay, the Bristol Channel and the English Channel. Just over half the recaptures (54.1 per cent) were from the release area.

There is no doubt that some of the plaice found in Caernarvon Bay in autumn had migrated from Red Wharf Bay during the southerly migration mentioned previously. Thus the southerly recaptures of plaice tagged in Caernarvon Bay in autumn are at least partly explained as including some fish from Red Wharf Bay on passage to the south. The question as to whether all the southerly recaptures can be explained on this basis or whether some are plaice indigenous to Caernarvon Bay must remain open.

(ii) *Cardigan Bay* (*Figure 12, Appendix Table 9*)

In addition to the release in Cardigan Bay in March 1964, which was described in a previous section, plaice were tagged on two other occasions, as follows: 247 in June 1962; 38 (in Tremadoc Bay) in October 1964. Perhaps the most noteworthy feature of these two latter experiments was the very low recapture rate, for example 4.9 per cent in 1962 (Table 1). This may be compared with recapture rates of 38.1 and 50.2 per cent from releases made in two other areas (Morecambe Bay and Caernarvon Bay respectively) at the same time. (The Morecambe Bay release has not been described, since only 63 plaice were tagged.) The low recapture rate of the Cardigan Bay fish may indicate that most of them remained in the bay and that fishing effort there was low.

Plaice which were returned from outside Cardigan Bay accounted for two-thirds of the recaptures. There were no returns to the north, in contrast to the experiment at spawning time, in which the predominant movement was northwards (Figure 7); the main direction of movement in the present case was southwards. The complexity of movements of plaice in the Irish Sea is further illustrated when this release is compared with the one in Caernarvon Bay, which took place at the same time (Figure 10). In the latter case, the main movement was northwards and there were no recaptures to the south.

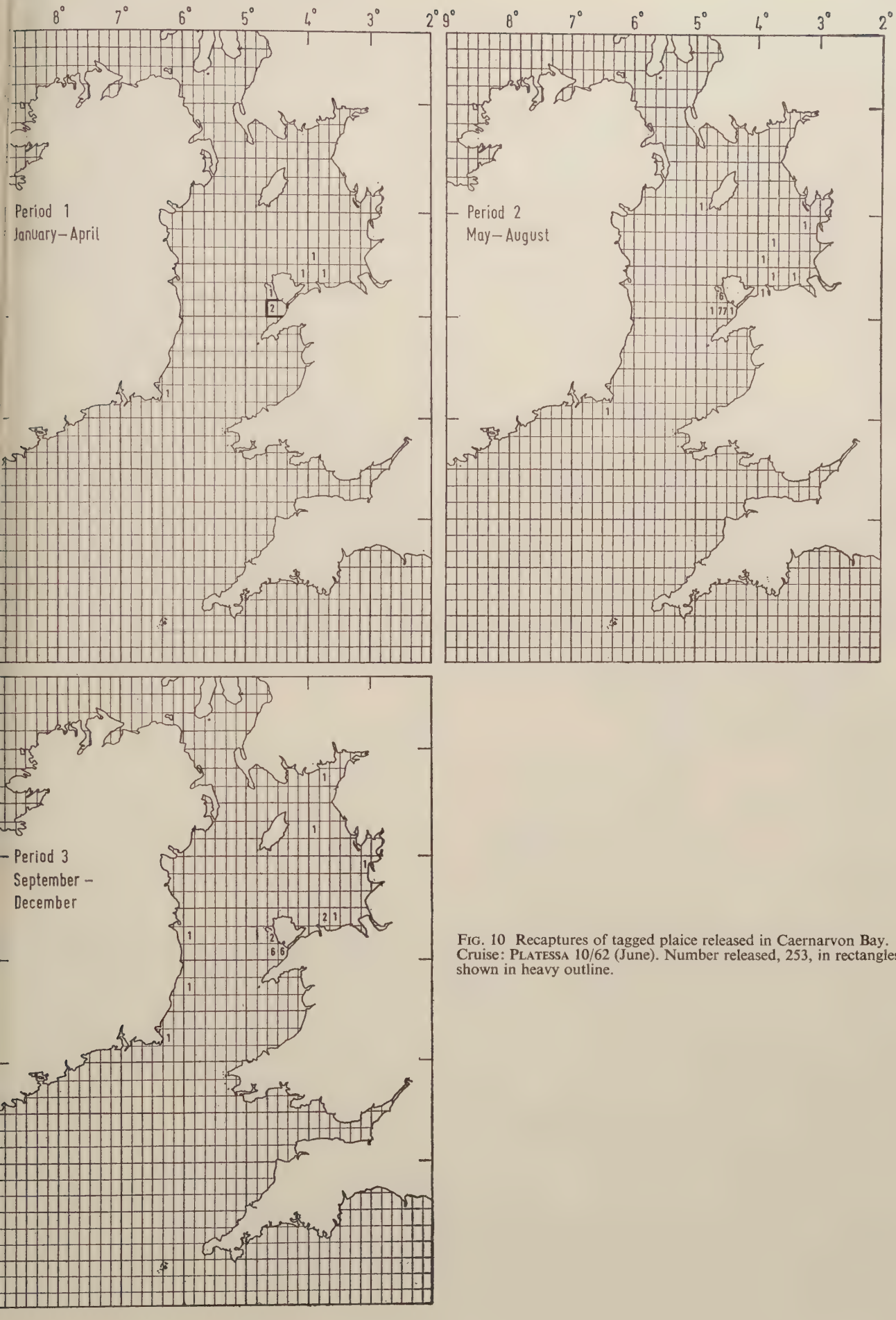


FIG. 10 Recaptures of tagged plaice released in Caernarvon Bay. Cruise: PLATESSA 10/62 (June). Number released, 253, in rectangles shown in heavy outline.

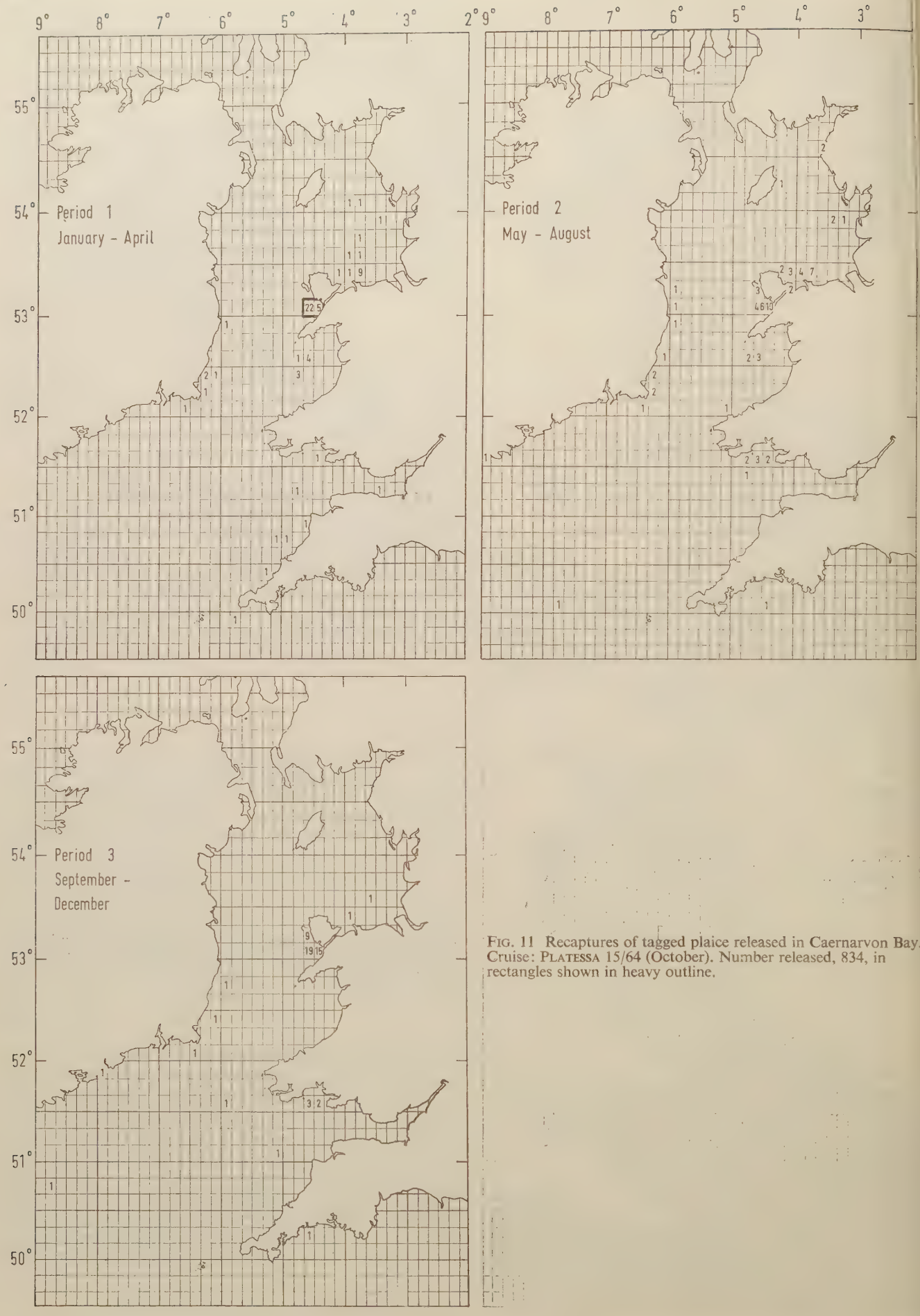


FIG. 11 Recaptures of tagged plaice released in Caernarvon Bay. Cruise: PLATESSA 15/64 (October). Number released, 834, in rectangles shown in heavy outline.

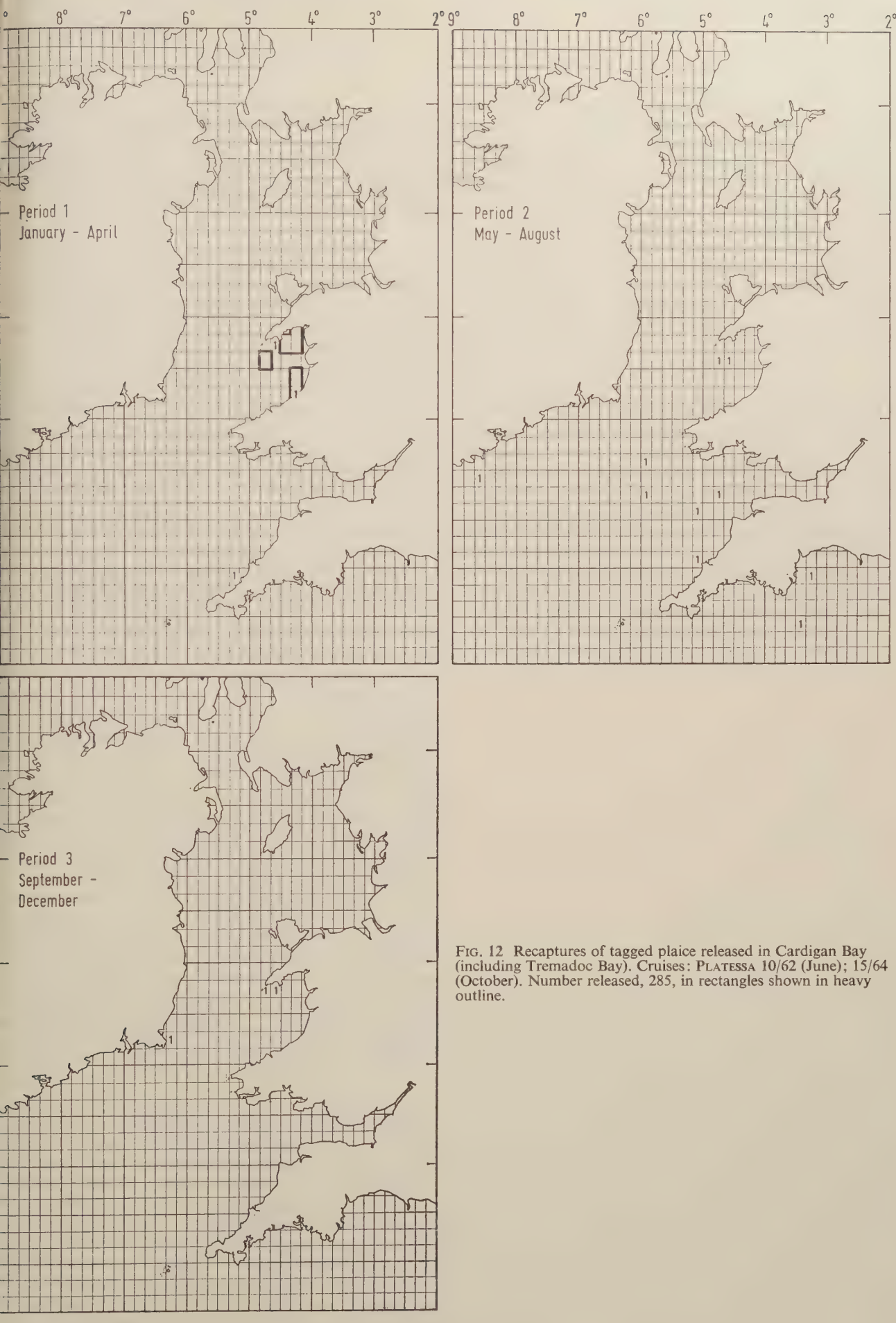


FIG. 12 Recaptures of tagged plaice released in Cardigan Bay (including Tremadoc Bay). Cruises: PLATESSA 10/62 (June); 15/64 (October). Number released, 285, in rectangles shown in heavy outline.

iscussion

m the foregoing account it is apparent that the patterns novement of Irish Sea plaice are far from simple, so that extremely difficult to make generalizations about them. results are summarized in Appendix Table 1, which also udes data from releases in the English Channel, which be referred to below.

n the north-east Irish Sea, most of the mature plaice rn each year to the same spawning ground, either off at Ormes Head or St Bees Head. After spawning, the disperse throughout the area but only a small proportion ve it completely. Plaice tagged in inshore areas off mberland (Hill 1971), Lancashire (Johnstone *et al.* 1922) l in Red Wharf Bay (Johnstone *et al.* 1922, Daniel and ming 1933, present work) consisted, in each case, of a xture of mature and immature fish. Off the Cumberland d Lancashire coasts, the plaice typically showed localized sonal movements. There was an offshore movement ring the summer and, in the Lancashire experiments, a urn movement inshore of the immature plaice during the nter, while the mature fish migrated to the spawning ounds, some moving to St Bees Head and others to Great mes Head. It would seem likely from Hill's (1971) data at the mature Cumberland plaice spawn off St Bees Head.

The plaice tagged inshore in Red Wharf Bay in autumn owed a different pattern from the one described above. nly about one half of the recaptures showed localized ovements, and the remainder, which probably included th mature and immature plaice, were recaptured outside e north-east Irish Sea, mainly in areas to the south. This ndency was much less marked in a small batch of plaice leased in the summer and it has therefore been suggested ove that Red Wharf Bay is an area where plaice, which e leaving the north-east Irish Sea in autumn, collect. lthough there have apparently been no recaptures of umberland or Lancashire plaice in Red Wharf Bay, there ave been returns of Lancashire fish in the Bristol Channel ea (Johnstone *et al.* 1922, Daniel and Fleming 1933).

The most likely reason why mature plaice occurring in ed Wharf Bay in autumn migrate south instead of spawng off Great Ormes Head is probably that they had preiously migrated northwards after spawning in one of the reas to the south. The evidence for this is that there were ecaptures in the north-east Irish Sea of plaice tagged on ne spawning grounds in Cardigan Bay and the Bristol Channel.

If, as appears likely, there is also a southerly migration f immature plaice from Red Wharf Bay, the reasons for it re less clear. It is not known, for example, if these fish are ndigenous to the north-east Irish Sea or to some other area o the south. The fact that the migration takes place in utumn might be taken to suggest that it has to do with emperature, that is, it is an overwintering migration. The laice is, however, a north-boreal species (Rass 1959), ccurring from the White Sea to Cadiz (Norman 1934), so hat a southwards migration in the Irish Sea is a movement owards the southern limit of its range. Such a movement ould be a *fail-safe* mechanism by which the populations at ne extreme of the geographical range are reinforced or eplenished in case of adverse environmental conditions. This mechanism could be achieved by egg and larval drift, by migration of mature fish, or by migration of immature fish. In the Irish Sea, the main current flow is northwards, so precluding large-scale planktonic drift to the south, although localized gyres probably do occur (Lee 1960). Moreover, there would seem to be an ecological advantage in immature, rather than mature, fish making such migrations. The fact that most fish species have fixed spawning areas suggests that these areas have advantages which have been selected for in the course of evolution, so that once having spawned in such an area, there would be a selective advantage in returning in subsequent years. In this sense, immature fish are more expendable than mature ones, should they arrive in unfavourable habitats.

There have been recaptures in the English Channel from plaice liberated in all the release areas (Appendix Table 1) and it is therefore of some interest to know whether return movements occur. Some information on this point is available from tagging carried out by the Lowestoft laboratory in Start Bay and Lyme Bay in 1959 and again in 1965. A total of 466 plaice were released and of the 105 recaptures only one was from the Irish Sea (Bristol Channel area), so it would seem that there is very little return movement. This would fit in with the idea of replenishment of stocks on the fringes of distribution, as outlined above.

ummary

Plaice tagged on four spawning grounds in the Irish Sea Bees Head, Great Ormes Head, Cardigan Bay, Trevose d) showed a tendency to return to the same spawning . each year, and, except for the St Bees fish, dispersed in redominantly northerly direction after spawning. Very of the St Bees or Great Ormes Head fish were recaught side the north-east Irish Sea but plaice from the other spawning grounds showed wider dispersal.

Approximately one half of the recaptures from an in- re mixed population of mature and immature plaice, ged in autumn in Red Wharf Bay, showed a tendency to ve southwards, as far as the western English Channel. ause there was no difference between the mean lengths the migrant and non-migrant plaice, it is inferred that h groups included mature and immature fish. It is sug- ted that the mature migrants were returning to their ial spawning grounds and that the movement of the mature migrants constitutes a mechanism for continuous olonization of areas near one extreme of the species nge.

From releases in Caernarvon Bay in June and October, proximately one half of the recaptures were from outside bay (disregarding recaptures at a time of heavy fishing t after release in the June experiment). In both experi- nts there were recaptures to the north and west but only m the October release were there returns from the south. e latter probably included south-going migrants from Red harf Bay.

A small release in June in Cardigan Bay resulted in a ry low recapture rate (4.9 per cent), with returns to the uth but none to the north.

Although there were recaptures in the western English annel from experiments in all release areas, there appears be very little return movement.

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APPENDIX TABLE 1 *Summary of tagging results. Percentage recaptures from each release area. Numbers in parentheses are the returns excluding the first year*

Recapture area	Release area									
	St Bees Head	Great Ormes Head	Red Wharf Bay	Caernarvon Bay		Cardigan Bay		Bristol Channel	Western English Channel	
				June	October	March	June			
St Bees Head	26.3 (30.0)	4.8 (3.2)	1.0 (1.1)	0.8 (–)	0.8 (1.0)	1.4 (–)	– (–)	– (–)	–	(–)
Great Ormes Head	1.2 (1.3)	30.8 (32.2)	30.6 (13.9)	6.3 (15.0)	13.0 (6.0)	5.4 (11.1)	– (–)	2.7 (–)	–	(–)
Other areas in NE. Irish Sea	66.8 (61.3)	56.8 (54.6)	18.3 (24.7)	6.3 (20.0)	4.9 (5.0)	13.5 (11.1)	– (–)	10.8 (–)	–	(–)
Caernarvon Bay	0.4 (–)	1.9 (2.6)	10.7 (9.4)	81.1 (50.0)	54.1 (57.0)	10.8 (11.1)	– (–)	2.7 (8.3)	–	(–)
Cardigan Bay	– (–)	0.4 (0.6)	4.4 (4.3)	– (–)	5.7 (2.0)	27.0 (33.3)	33.3 (20.0)	– (–)	–	(–)
Bristol Channel	0.4 (–)	0.8 (1.0)	16.6 (21.0)	– (–)	8.9 (9.0)	12.2 (3.7)	33.3 (40.0)	59.5 (66.7)	1.0	(–)
English Channel	– (–)	0.2 (0.1)	5.7 (7.3)	– (–)	1.2 (2.0)	– (–)	16.7 (20.0)	8.1 (–)	96.1	(90.3)
St George's Channel	– (–)	0.2 (0.3)	1.0 (1.9)	– (–)	0.8 (2.0)	– (–)	– (–)	5.4 (8.3)	–	(–)
SE. Irish coast	0.4 (–)	0.4 (0.5)	3.4 (5.6)	0.8 (5.0)	2.0 (4.0)	8.1 (14.8)	8.3 (10.0)	5.4 (–)	–	(–)
E. Irish coast	0.8 (1.3)	1.5 (1.5)	4.7 (5.2)	3.1 (5.0)	5.7 (6.0)	13.5 (11.1)	8.3 (10.0)	2.7 (8.3)	–	(–)
Other areas	0.4 (1.3)	0.6 (0.8)	0.9 (1.5)	– (–)	0.4 (–)	– (–)	– (–)	– (–)	–	(–)
Position unknown	3.2 (5.0)	1.7 (2.7)	2.9 (4.1)	1.6 (5.0)	2.4 (6.0)	8.1 (3.7)	– (–)	2.7 (8.3)	2.9	(9.7)

APPENDIX TABLE 2 *Details of recaptures of tagged plaice released off St Bees Head. Number released, 512; 22 February–2 March 1963 and 1964*

Recapture area	Year												Total
	1			2			3			4			
	Period												
	1	2	3	1	2	3	1	2	3	1	2	3	
NE. Irish Sea as follows:	65	69	25	34	16	10	5	–	4	1	3	1	233
St Bees Head	21	16	4	15	5	1	1	–	–	1	1	–	65
Gt Ormes Head	–	2	–	1	–	–	–	–	–	–	–	–	3
Elsewhere	44	51	21	18	11	9	4	–	4	–	2	1	165
Caernarvon Bay	–	1	–	–	–	–	–	–	–	–	–	–	1
Cardigan Bay	–	–	–	–	–	–	–	–	–	–	–	–	–
Bristol Channel	–	1	–	–	–	–	–	–	–	–	–	–	1
English Channel	–	–	–	–	–	–	–	–	–	–	–	–	–
St George's Channel	–	–	–	–	–	–	–	–	–	–	–	–	–
SE. Irish coast	1	–	–	–	–	–	–	–	–	–	–	–	1
E. Irish coast	1	–	–	–	1	–	–	–	–	–	–	–	2
Other areas	–	–	–	–	–	1	–	–	–	–	–	–	1
Position unknown	1	1	2	1	2	–	–	–	–	–	–	1	8
Total	68	72	27	35	19	11	5	–	4	1	3	2	247

APPENDIX TABLE 3 *Details of recaptures of tagged plaice released off Great Ormes Head. Number released, 11 037; 3 February–7 May 1960–65*

Recapture area	Year												Date unknown	Tot
	1			2			3			4				
	Period													
	1	2	3	1	2	3	1	2	3	1	2	3		
NE. Irish Sea as follows:	487	824	264	214	358	107	118	139	40	35	75	17	1	2 67
St Bees Head	19	64	16	6	18	2	6	3	–	2	2	–	–	13
Gt Ormes Head	329	118	51	145	56	12	92	36	9	27	14	4	–	89
Elsewhere	139	642	197	63	284	93	20	100	31	6	59	13	1	1 64
Caernarvon Bay	5	11	6	5	5	5	4	4	5	1	3	–	–	
Cardigan Bay	1	3	–	4	–	–	1	1	–	–	–	1	–	
Bristol Channel	1	7	3	1	5	–	1	2	–	1	2	–	–	
English Channel	–	–	6	–	–	1	–	–	–	–	–	–	–	
St George's Channel	–	–	2	2	2	–	–	–	–	–	–	–	–	
SE. Irish coast	–	6	1	1	3	–	–	1	1	–	–	–	–	
E. Irish coast	4	17	5	4	7	2	1	2	2	–	–	–	–	
Other areas	1	5	2	–	4	2	–	1	1	–	1	–	1	
Position unknown	1	6	8	13	4	5	–	5	3	–	2	1	–	
Total	500	879	297	244	388	122	125	155	52	37	83	19	2	2 90

APPENDIX TABLE 4 *Details of recaptures of tagged plaice released in Cardigan Bay. Number released, 246; 3–5 March 1964*

Recapture area	Year												Tot
	1			2			3			4			
	Period												
	1	2	3	1	2	3	1	2	3	1	2	3	
NE. Irish Sea as follows:	3	4	2	–	1	2	–	2	–	–	–	1	15
St Bees Head	–	1	–	–	–	–	–	–	–	–	–	–	1
Gt Ormes Head	1	–	–	–	1	1	–	–	–	–	–	1	4
Elsewhere	2	3	2	–	–	1	–	2	–	–	–	–	10
Caernarvon Bay	3	1	1	1	–	1	–	–	–	1	–	–	8
Cardigan Bay	8	3	–	1	2	1	2	1	–	–	–	–	18
Bristol Channel	–	8	–	–	1	–	–	–	–	–	–	–	9
English Channel	–	–	–	–	–	–	–	–	–	–	–	–	–
St George's Channel	–	–	–	–	–	–	–	–	–	–	–	–	–
SE. Irish coast	1	1	–	1	1	–	–	2	–	–	–	–	6
E. Irish coast	2	3	2	–	–	1	1	1	–	–	–	–	10
Other areas	–	–	–	–	–	–	–	–	–	–	–	–	–
Position unknown	–	4	1	–	–	–	1	–	–	–	–	–	6
Total	17	24	6	3	5	5	4	6	–	1	–	1	72

NDIX TABLE 5 *Details of recaptures of tagged plaice released off Trevose Head. Number released, 100; 2–5 April 1959*

ture area	Year									Total
	1			2			3		4	
	Period									
	1	2	3	1	2	3	1	2–3	1–3	
Irish Sea as follows:	–	4	1	–	–	–	–	–	–	5
Bees Head	–	–	–	–	–	–	–	–	–	–
Ormes Head	–	1	–	–	–	–	–	–	–	1
sewhere	–	3	1	–	–	–	–	–	–	4
narvon Bay	–	–	–	–	–	1	–	–	–	1
digan Bay	–	–	–	–	–	–	–	–	–	–
ol Channel	3	11	–	5	2	–	1	–	–	22
ish Channel	–	3	–	–	–	–	–	–	–	3
eorge's Channel	–	1	–	–	1	–	–	–	–	2
Irish coast	–	1	1	–	–	–	–	–	–	2
ish coast	–	–	–	–	1	–	–	–	–	1
r areas	–	–	–	–	–	–	–	–	–	–
tion unknown	–	–	–	–	–	–	1	–	–	1
l	3	20	2	5	4	1	2	–	–	37

PENDIX TABLE 6 *Details of recaptures of tagged plaice released in Red Wharf Bay and adjacent bays. Number released, 3 245; 21 October–16 November 1962–64*

apture area	Year													Date unknown	Total
	1	2			3			4			5				
	Period														
	3	1	2	3	1	2	3	1	2	3	1	2	3		
. Irish Sea as follows:	109	27	145	41	9	43	29	3	25	14	–	15	6	–	466
t Bees Head	–	1	3	2	1	1	1	–	–	–	–	–	–	–	9
Gt Ormes Head	102	21	98	18	4	11	12	3	10	3	–	4	–	–	286
lsewhere	7	5	44	21	4	31	16	–	15	11	–	11	6	–	171
rnarvon Bay	12	8	36	14	6	12	4	1	5	1	–	1	–	–	100
rdigan Bay	–	12	9	1	4	4	–	5	2	–	3	1	–	–	41
stol Channel	–	13	44	43	10	24	5	6	8	1	1	–	–	–	155
glish Channel	–	7	12	11	11	4	2	–	1	–	4	–	–	1	53
George's Channel	–	–	–	–	–	2	5	–	1	–	1	–	–	–	9
Irish coast	–	3	3	3	2	5	10	2	4	–	–	–	–	–	32
Irish coast	–	2	18	7	3	2	6	2	2	–	1	–	1	–	44
ner areas	–	–	1	–	3	1	1	1	–	–	–	–	–	1	8
sition unknown	–	2	6	1	4	6	5	–	2	–	–	–	–	1	27
tal	121	74	274	121	52	103	67	20	50	16	10	17	7	3	935

APPENDIX TABLE 7 *Details of recaptures of tagged plaice released in Caernarvon Bay. Number released, 253; 2–3 June 1962*

Recapture area	Year									
	1		2			3			4	
	Period									
	2	3	1	2	3	1	2	3	1	2–3
NE. Irish Sea as follows:	3	6	1	3	1	–	1	–	2	–
St Bees Head	–	1	–	–	–	–	–	–	–	–
Gt Ormes Head	2	2	1	–	1	–	–	–	2	–
Elsewhere	1	3	–	3	–	–	1	–	–	–
Caernarvon Bay	82	11	–	2	3	3	1	–	–	–
Cardigan Bay	–	–	–	–	–	–	–	–	–	–
Bristol Channel	–	–	–	–	–	–	–	–	–	–
English Channel	–	–	–	–	–	–	–	–	–	–
St George's Channel	–	–	–	–	–	–	–	–	–	–
SE. Irish coast	–	–	–	1	–	–	–	–	–	–
E. Irish coast	–	2	1	–	1	–	–	–	–	–
Other areas	–	–	–	–	–	–	–	–	–	–
Position unknown	1	–	–	1	–	–	–	–	–	–
Total	86	19	2	7	5	3	2	–	2	–

APPENDIX TABLE 8 *Details of recaptures of tagged plaice released in Caernarvon Bay. Number released, 834; 19–20 October 1964*

Recapture area	Year													
	1	2			3			4			5			
	Period													
	3	1	2	3	1	2	3	1	2	3	1	2	3
NE. Irish Sea as follows:	1	13	20	2	4	3	1	–	1	–	–	–	1
St Bees Head	–	1	–	–	–	1	–	–	–	–	–	–	–
Gt Ormes Head	–	11	15	2	2	1	–	–	–	–	–	–	1
Elsewhere	1	1	5	–	2	1	1	–	1	–	–	–	–
Caernarvon Bay	17	18	41	19	4	8	3	5	10	4	–	2	2
Cardigan Bay	–	6	6	–	2	–	–	–	–	–	–	–	–
Bristol Channel	–	6	7	6	1	1	1	–	–	–	–	–	–
English Channel	–	–	1	1	–	–	–	1	–	–	–	–	–
St George's Channel	–	–	–	1	–	1	–	–	–	–	–	–	–
SE. Irish coast	–	1	–	–	–	2	1	–	–	1	–	–	–
E. Irish coast	–	2	6	1	2	–	–	–	2	1	–	–	–
Other areas	–	–	1	–	–	–	–	–	–	–	–	–	–
Position unknown	–	–	–	3	2	–	–	1	–	–	–	–	–
Total	18	46	82	33	15	15	6	7	13	6	–	2	3

DIX TABLE 9 *Details of recaptures of tagged plaice released in Cardigan Bay (including Tremadoc Bay). Number released, 285; 5–6 June 1962, 18 October 1964*

ıre area	Year										Total
	1	2			3			4			
	Period										
	3	1	2	3	1	2	3	1	2	3	
ish Sea as follows:	–	–	–	–	–	–	–	–	–	–	–
ees Head	–	–	–	–	–	–	–	–	–	–	–
ormes Head	–	–	–	–	–	–	–	–	–	–	–
where	–	–	–	–	–	–	–	–	–	–	–
urvon Bay	–	–	–	–	–	–	–	–	–	–	–
an Bay	1	1	–	1	–	1	–	1	1	–	6
Channel	–	–	4	–	1	1	–	–	–	–	6
n Channel	–	–	1	–	–	1	–	–	–	–	2
orge's Channel	–	–	–	–	–	–	–	–	–	–	–
sh coast	–	–	1	–	–	–	–	–	–	–	1
h coast	–	–	–	1	–	–	–	–	–	–	1
areas	–	–	–	–	–	–	–	–	–	–	–
on unknown	–	–	–	–	–	–	1	–	–	–	1
	1	1	6	2	1	3	1	1	1	–	17

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